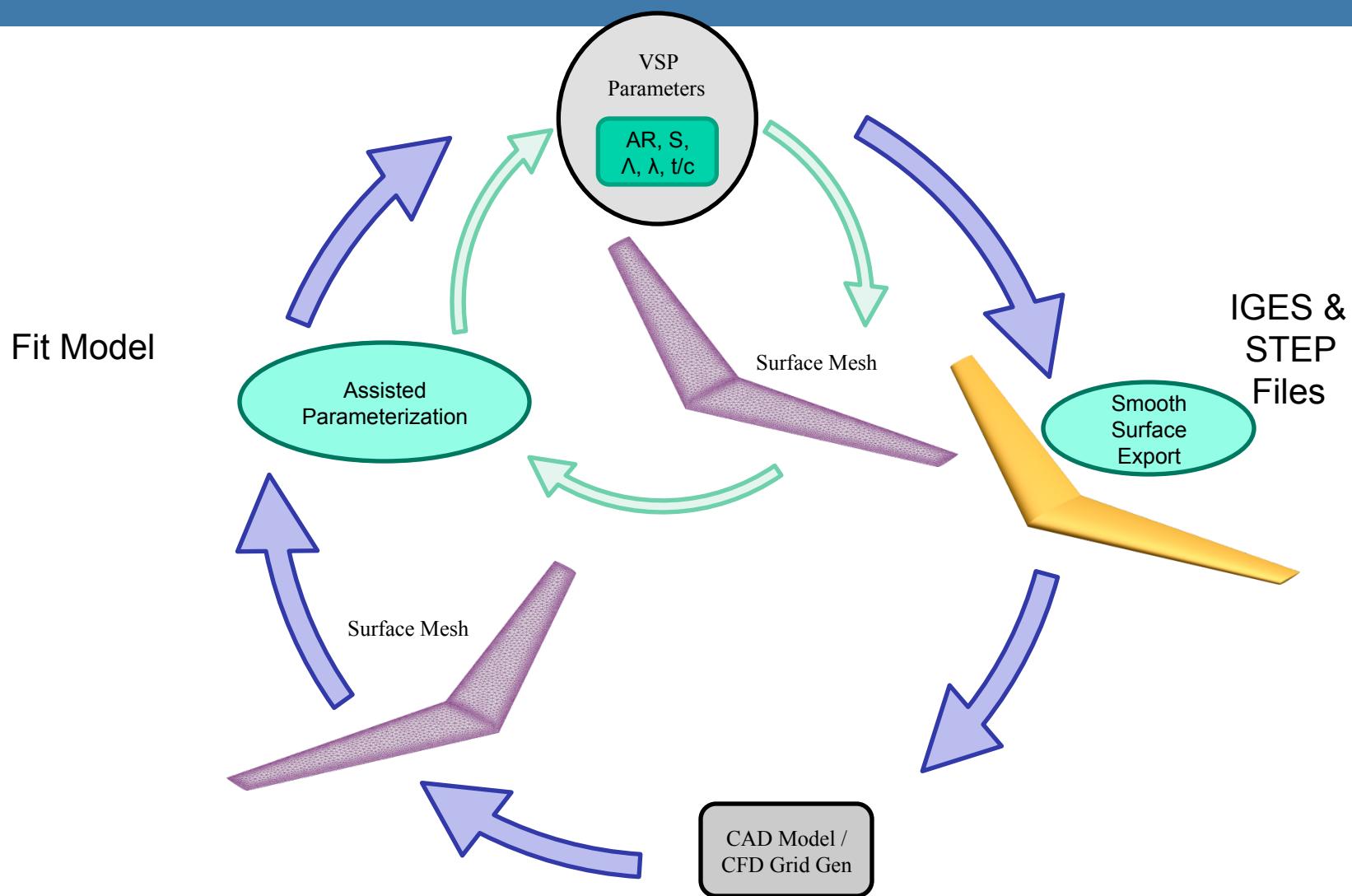


Fit Model

Interactive Reconstruction of 3D Models in OpenVSP

Rob McDonald

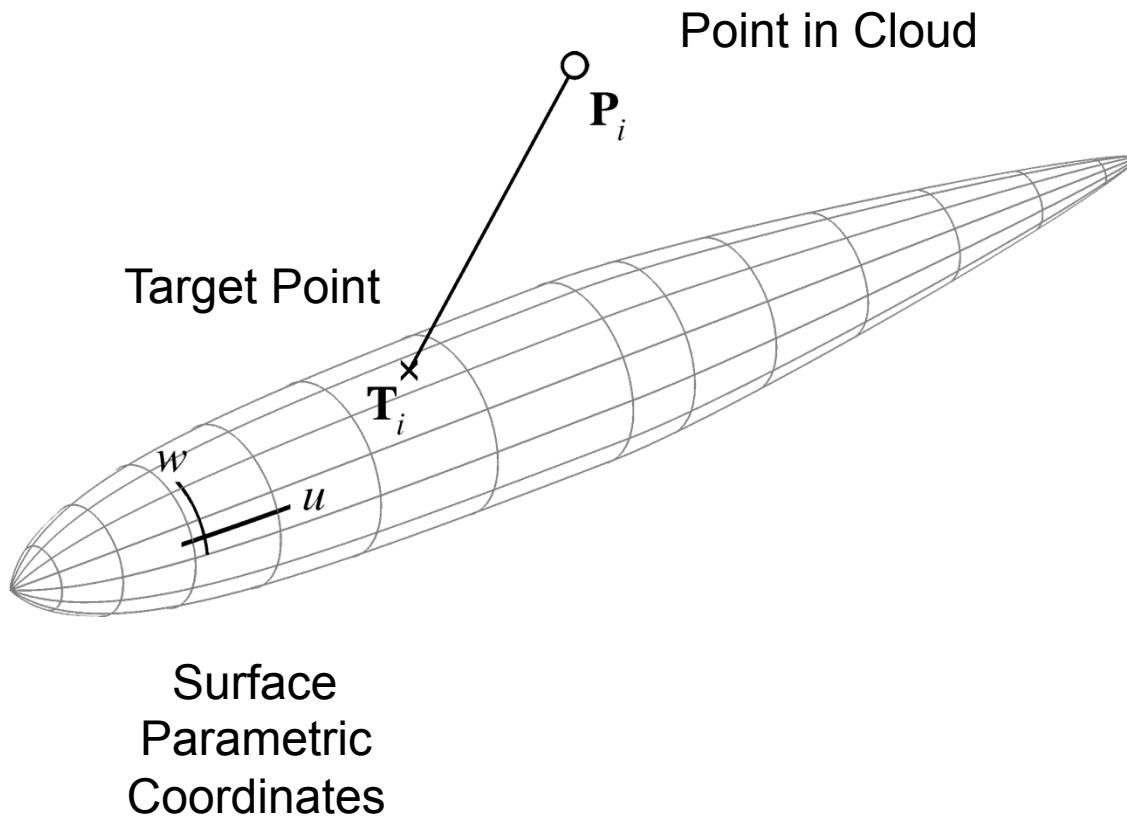
VSP To CAD Interoperability



Fit Model Use Case

- Reverse engineer physical object
 - Laser scan
 - Aircraft, Part, Tunnel model, etc.
- Interoperate with legacy model
 - CAD model
 - Surface mesh
- Aircraft Derivative or Modification
 - Re-winging existing aircraft
 - Stretch fuselage
 - Adapt to alternative mission
- Baseline for design study
 - Match model
 - V & V of analysis or design process
 - Gain parameterization
- Do not want a ‘dumb’ fit
 - OpenVSP Parameters
 - Match ‘native’ model in creation

Nomenclature

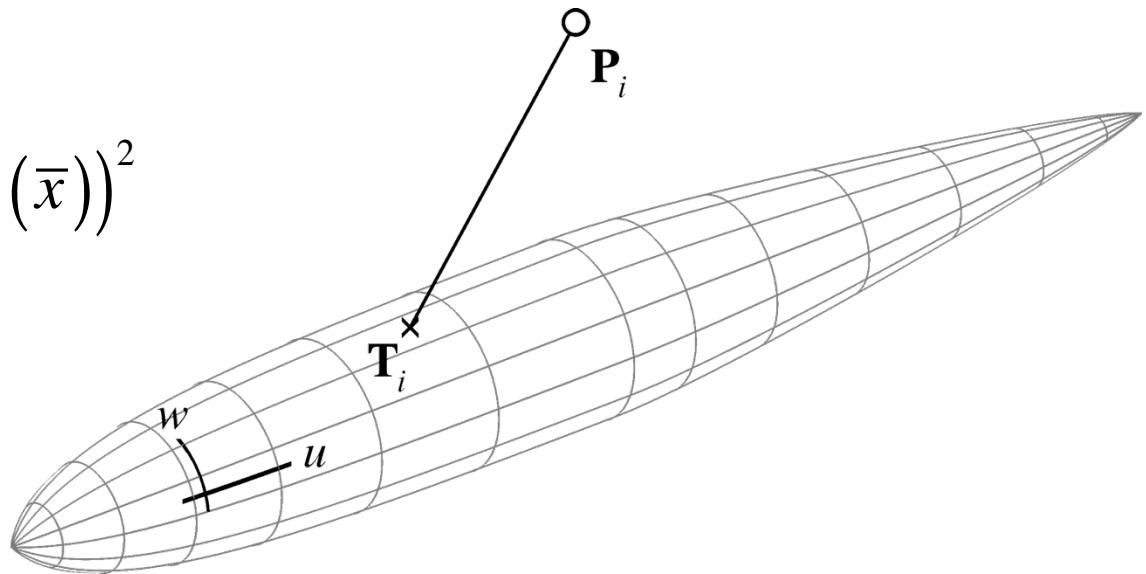


Least Squares Formulation

$$\min(F(\bar{x}))$$

$$F(\bar{x}) = \sum_{l=1}^m \sum_{k=1}^3 (P_{l,k} - T_{l,k}(\bar{x}))^2$$

$$\bar{x} = \{\bar{V}, \bar{u}_{free}, \bar{w}_{free}\}$$

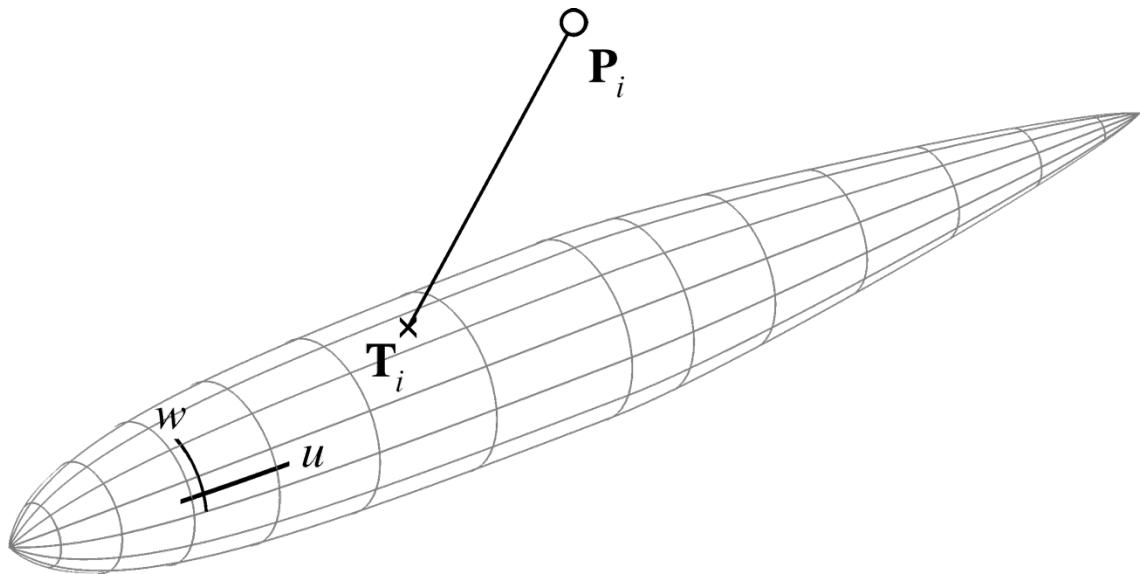


C/C++ Minpack Form

$$F(\bar{x}) = \sum_{i=1}^{3*m} (f_i(\bar{x}))^2$$

$$f_i(\bar{x}) = P_i - T_i(\bar{x})$$

$$\left. \frac{\partial f_i}{\partial x_j} \right|_{\bar{x}}$$



Recall: $\bar{x} = \{\bar{V}, \bar{u}_{free}, \bar{w}_{free}\}$

The Optimization Problem

- The user must:
 - Identify cloud point / target point pairing
 - Identify each target u, w as fixed or free
 - Specify values for any u, w fixed
 - Identify parameters V
 - Control the optimizer

Recall:

$$\min(F(\bar{x}))$$

$$F(\bar{x}) = \sum_{l=1}^m \sum_{k=1}^3 (P_{l,k} - T_{l,k}(\bar{x}))^2$$

$$\bar{x} = \{\bar{V}, \bar{u}_{free}, \bar{w}_{free}\}$$

Fit Model GUI designed around helping the user pose the optimization problem.

Fit Model GUI

The image displays three windows of a Fit Model GUI, showing different stages or configurations of the software.

Left Window (Main View):

- Top Bar:** Pick Points, Pick Vars, Var Tree, Fit Model, Save/Import.
- Point Selection:**
 - Num Selected: 0
 - Select One, Select Region, Select All, Select None, Invert Selection, Invert Hidden.
- Target Points:**

GEOM	X	Y	Z	U	Type	W	Type
PodGeom	8.42	-5.68	8.45	0.71	free	0.91	free
PodGeom	7.86	-7.06	8.61	0.67	free	0.89	free
PodGeom	9.42	-7.30	9.78	0.76	free	0.90	free
PodGeom	7.14	-9.29	5.95	0.62	free	0.84	free
PodGeom	7.25	-8.98	7.29	0.63	free	0.86	free
PodGeom	7.02	-7.92	5.91	0.62	free	0.85	free
PodGeom	8.02	-5.65	6.23	0.70	free	0.88	free
PodGeom	7.65	-6.07	7.33	0.67	free	0.89	free
PodGeom	8.90	-4.76	6.52	0.76	free	0.90	free
PodGeom	12.22	-2.39	11.02	0.08	free	0.00	free
- Bottom Control:**
 - Geom: 1_PodGeom
 - Free, Fix buttons for U and W.
 - Add Target, Delete Target, Clear Target buttons.
 - Num Target Pts.: 150
- Optimizer Control:**
 - DOF: 300, Conditions: 450
 - Search UW, Refine UW buttons.
 - Update Distance, Fit buttons.
 - Distance Metric: 11.429668

Middle Window (Zoomed View):

- Top Bar:** Pick Points, Pick Vars, Var Tree, Fit Model, Save/Import.
- Variables:** A list of variables with their values: U (15.000), W (10.000), X (0.000), Y (0.000), Z (0.000), U (0.000), W (0.000), X (0.000), Y (0.000), Z (0.000).
- Optimizer Control:**
 - Conditions: 450
 - Refine UW, Fit buttons.

Right Window (Zoomed View):

- Top Bar:** Pick Points, Pick Vars, Var Tree, Fit Model, Save/Import.
- Variables:** A list of variables with their values: U (15.000), W (10.000), X (0.000), Y (0.000), Z (0.000), U (0.000), W (0.000), X (0.000), Y (0.000), Z (0.000).
- Optimizer Control:**
 - Conditions: 450
 - Refine UW, Fit buttons.

Pick Points

- Identify cloud point / target point pairing
- Identify each target u, w as fixed or free
- Specify values for any u, w fixed

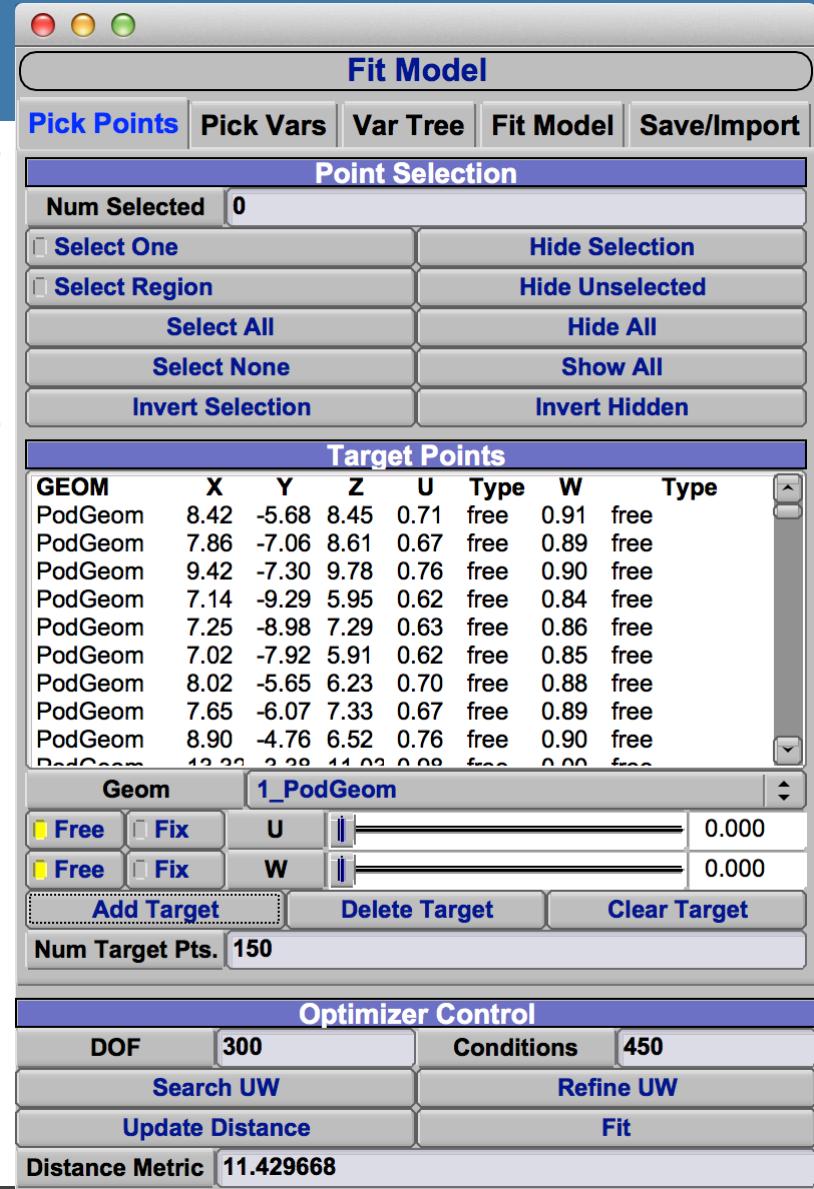
Point Selection

Target Point List

Target Component

Target Mode Control

Add/Delete Target Points



Pick Vars

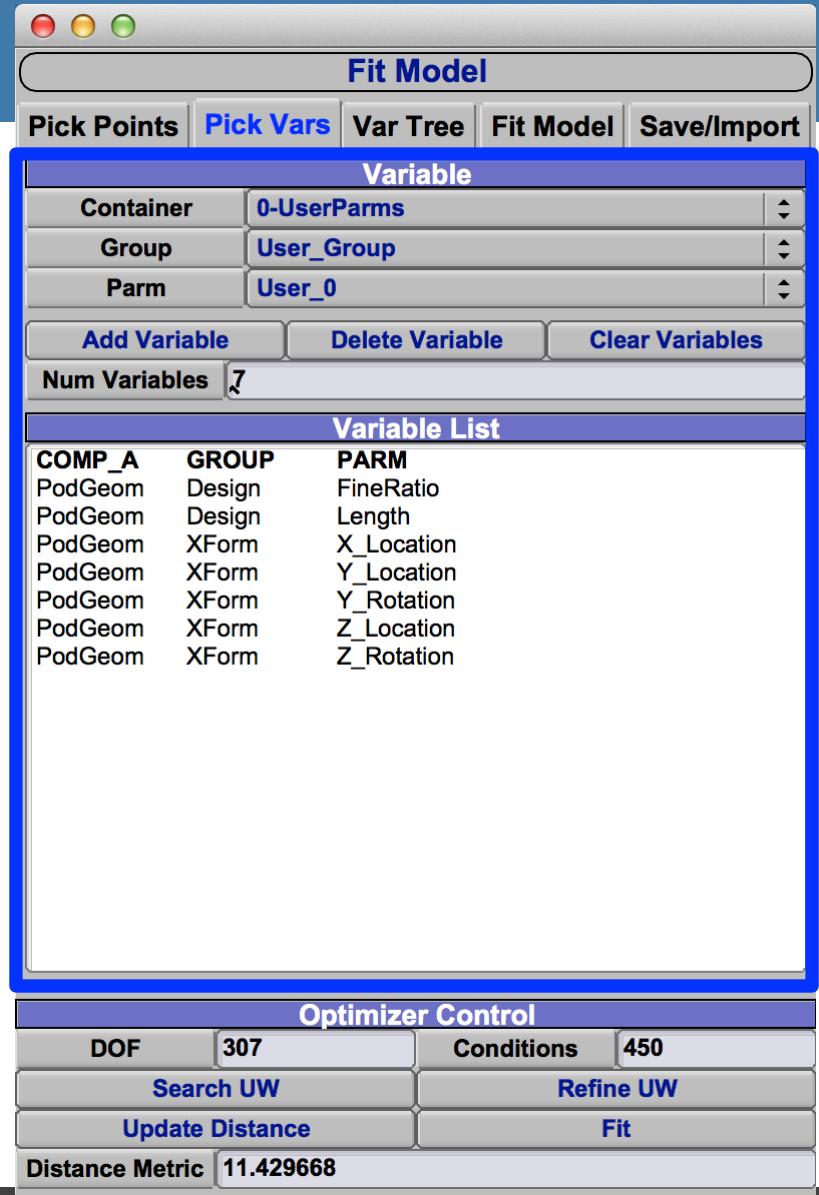
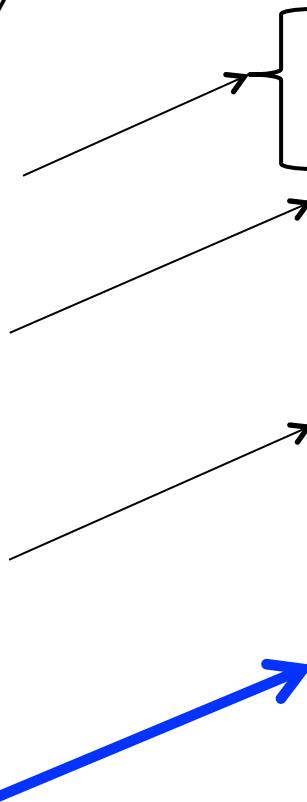
- Identify parameters V

Parameter Selection

Manipulate Variable List

Variable List

Drop Zone

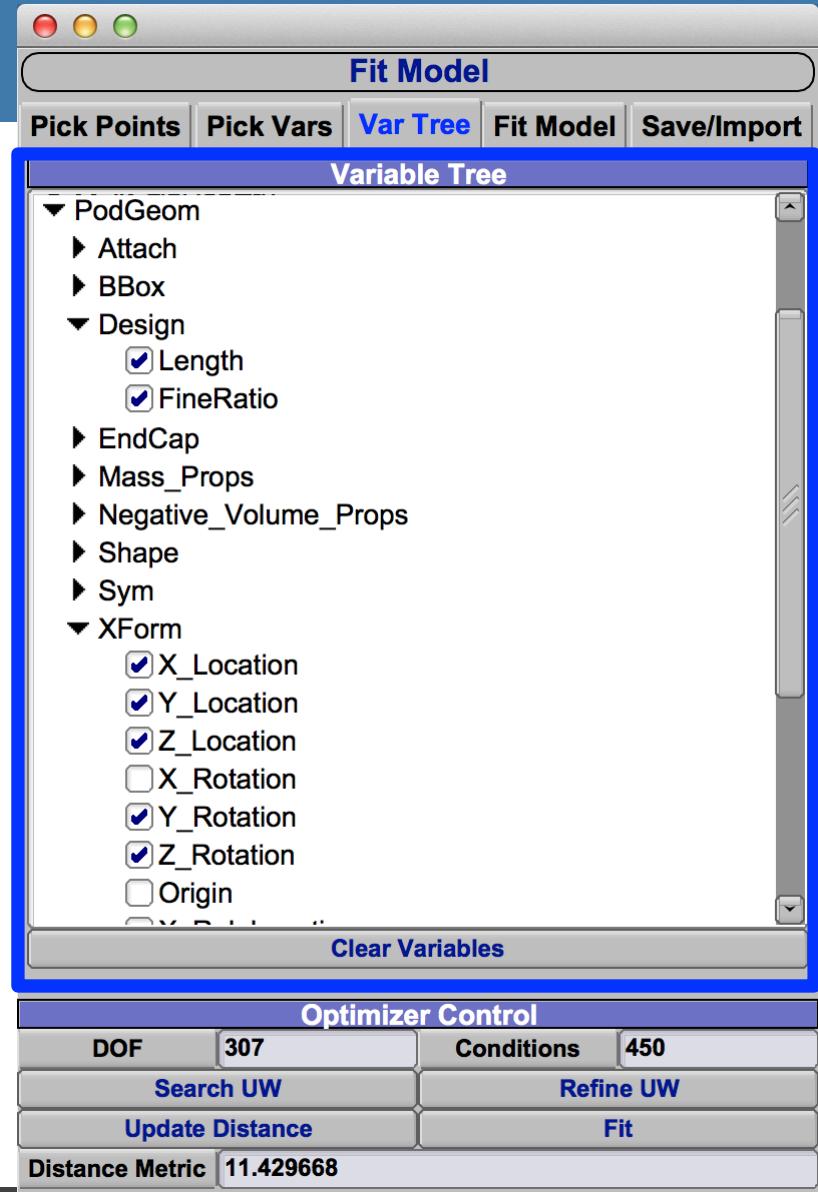


Var Tree

- Identify parameters V

Parameter Selection

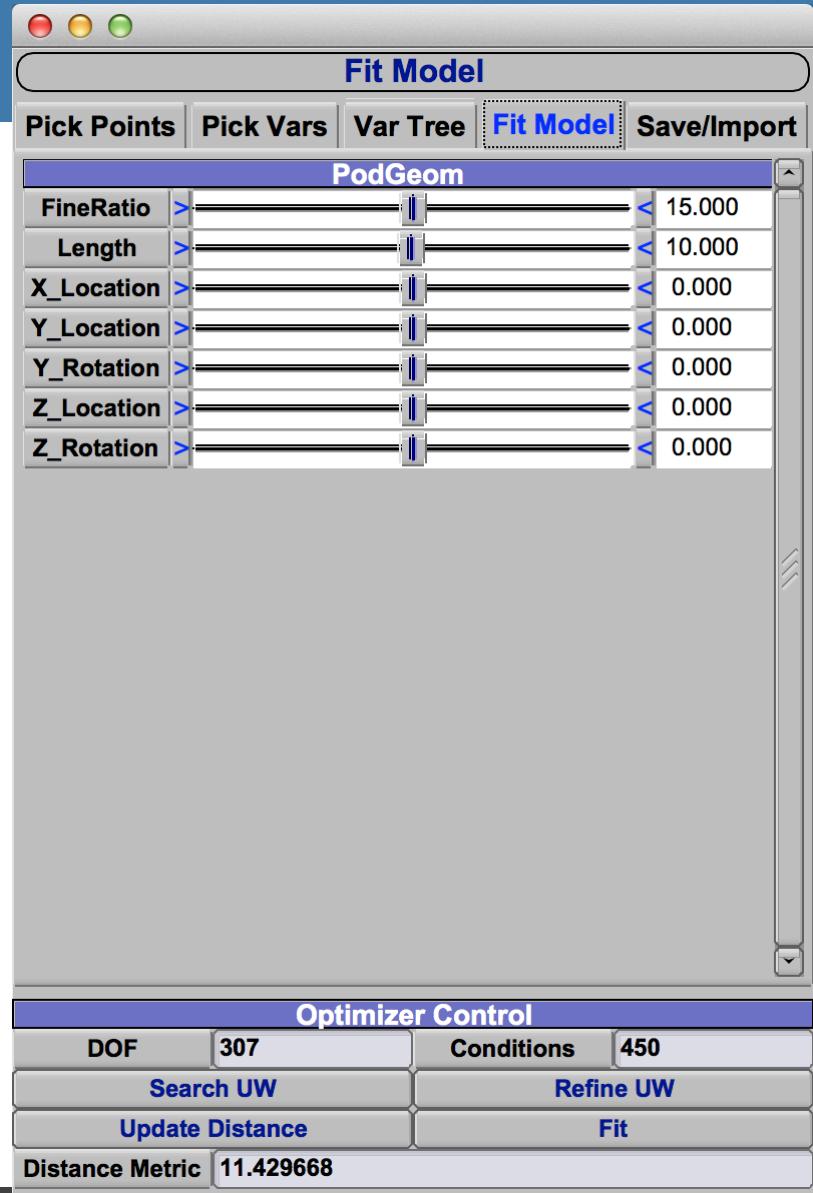
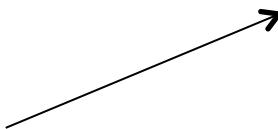
Drop Zone



Fit Model

- Control the variables

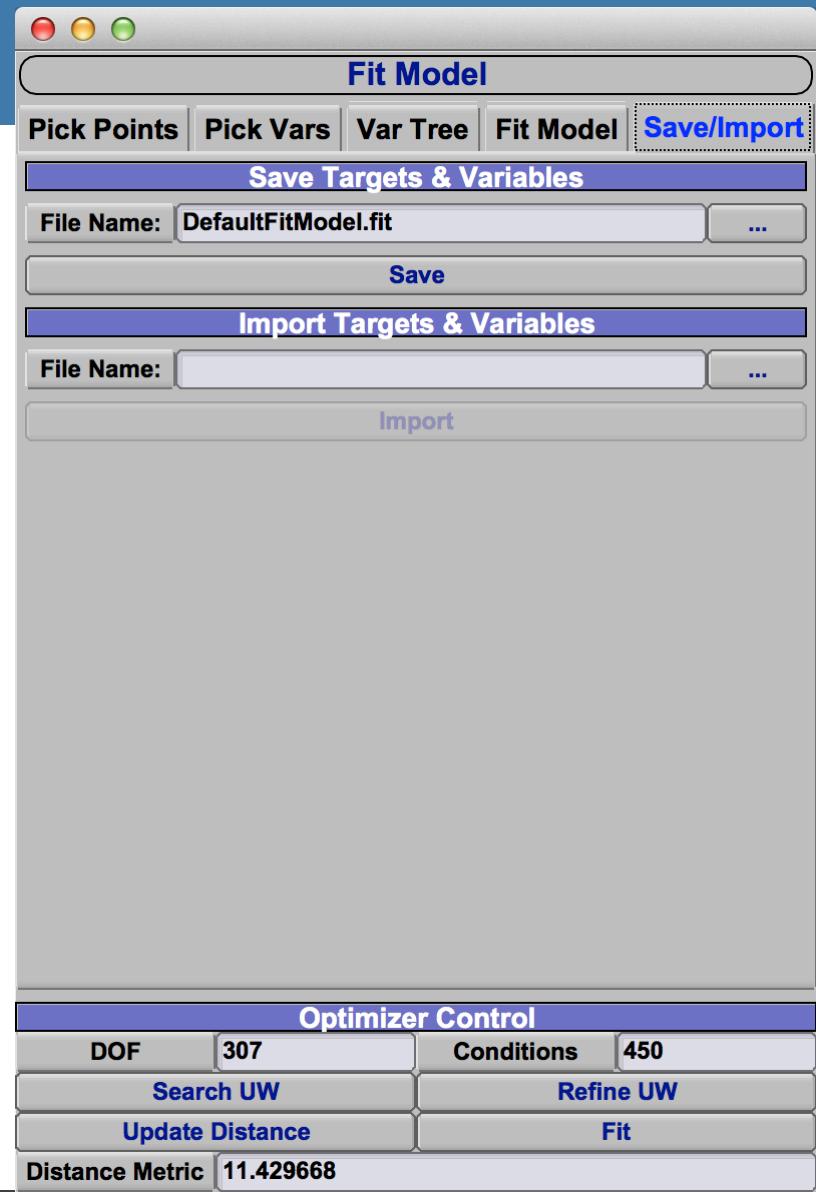
Manual
Variable Controls



Save/Import

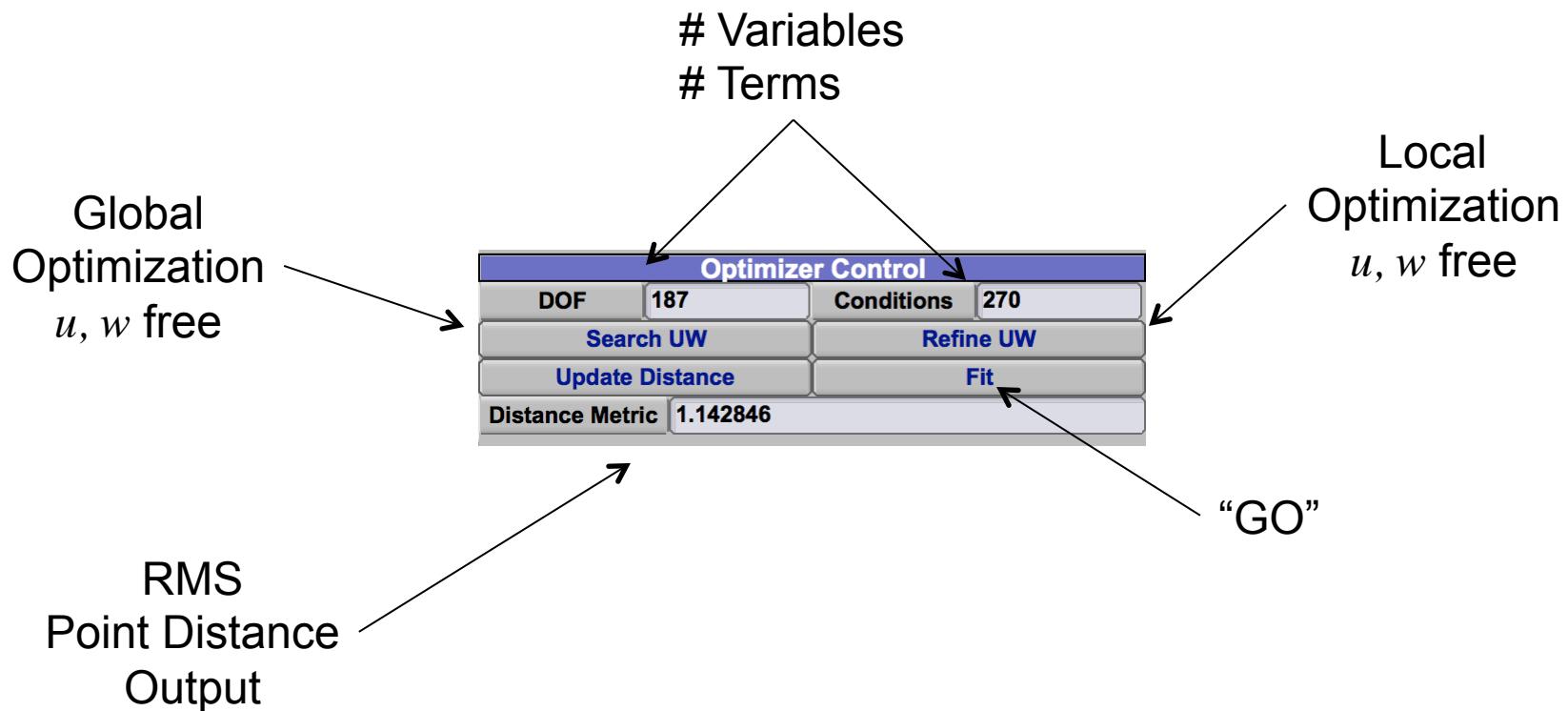
- Save and Import optimization problem

Save →
Import
(additive) →

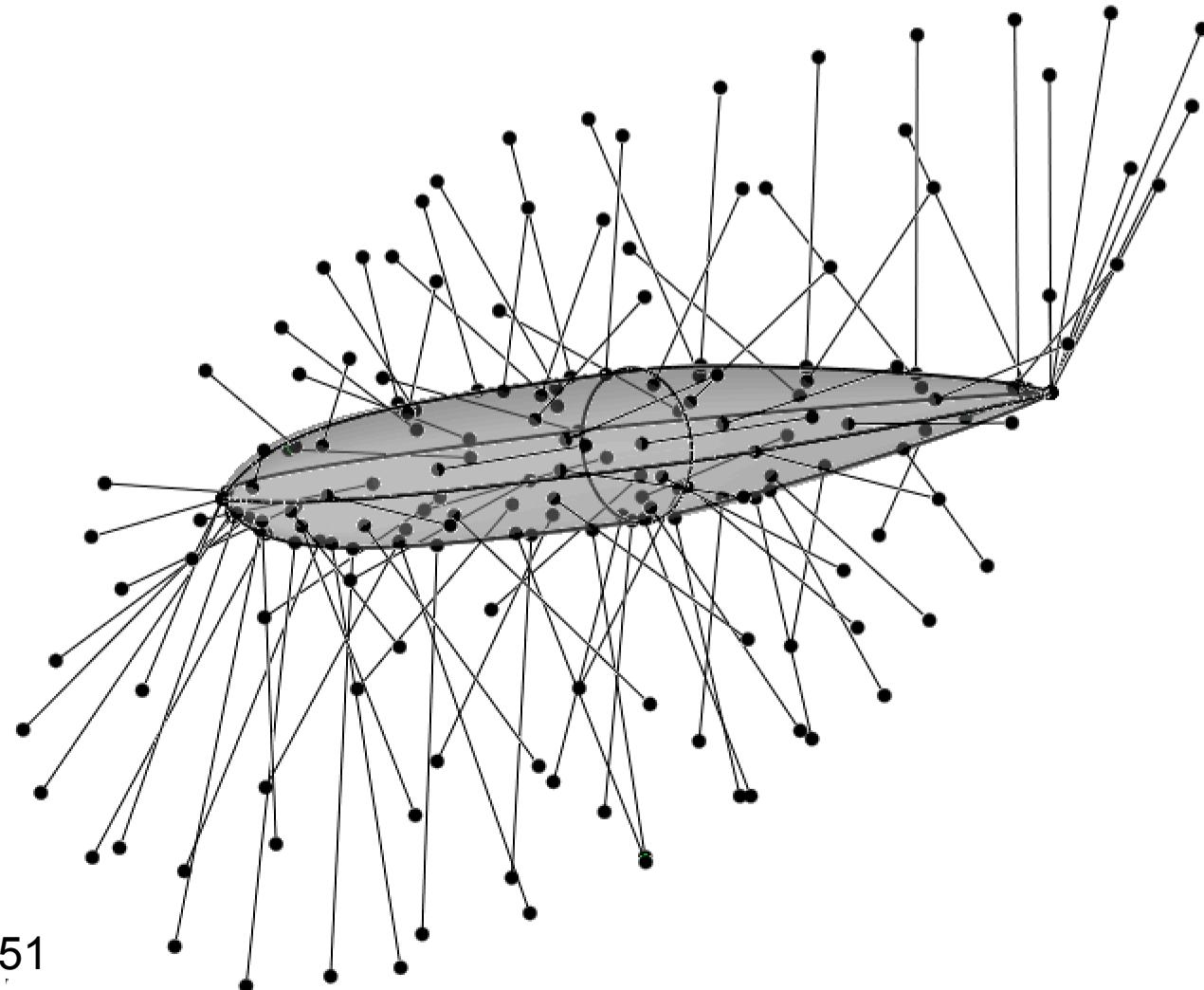


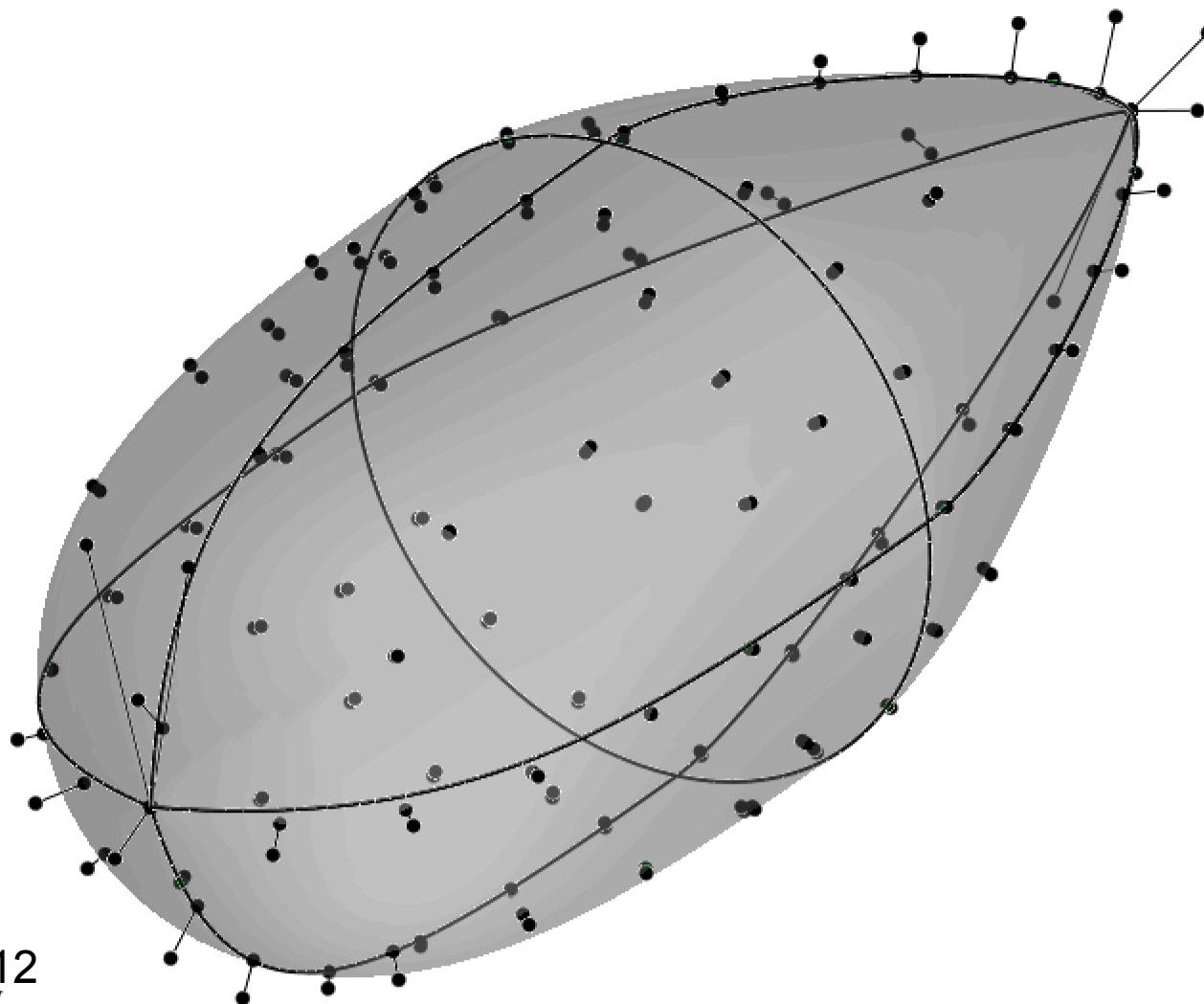
Fit Model

- Control the optimizer

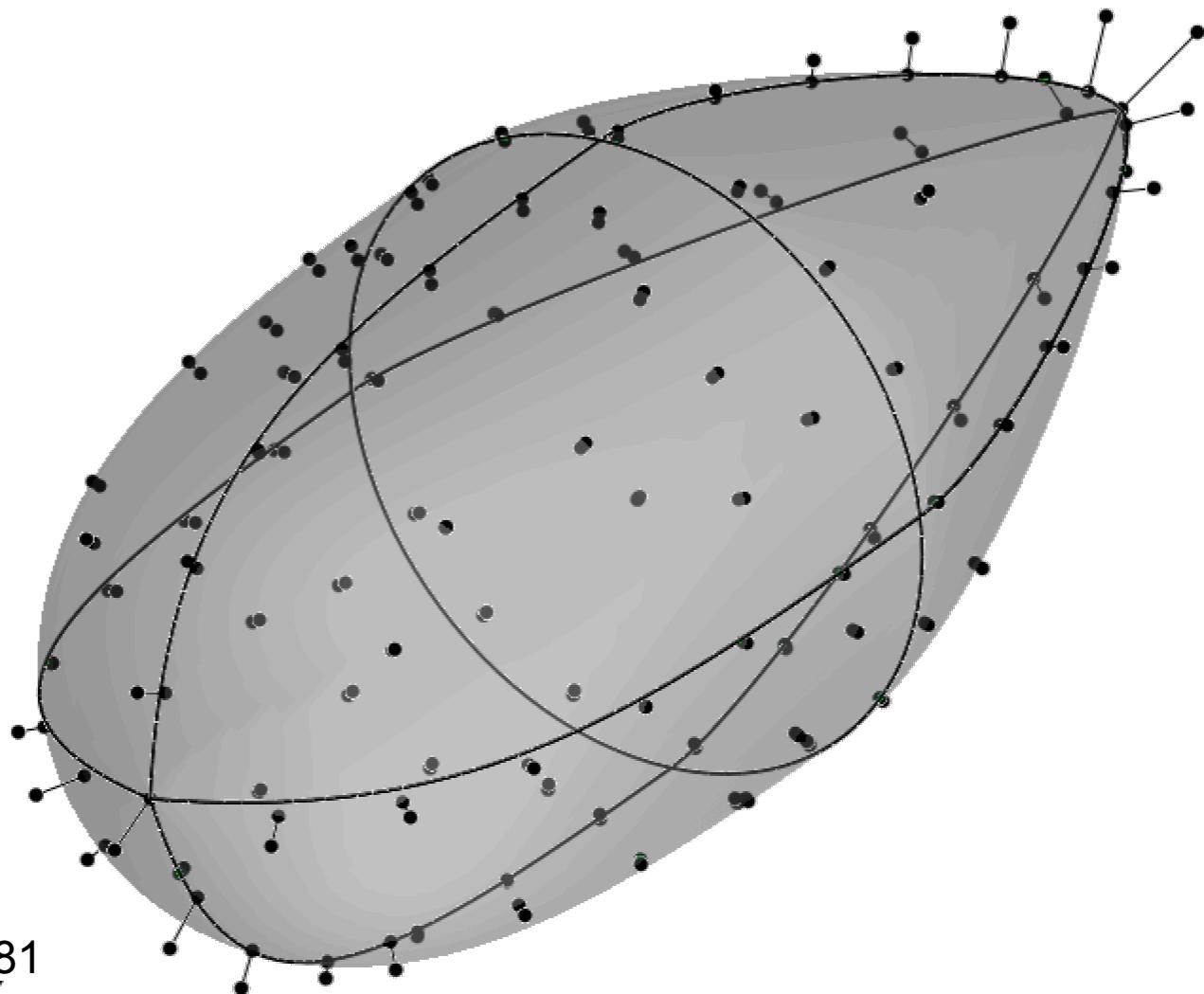


Simple Example

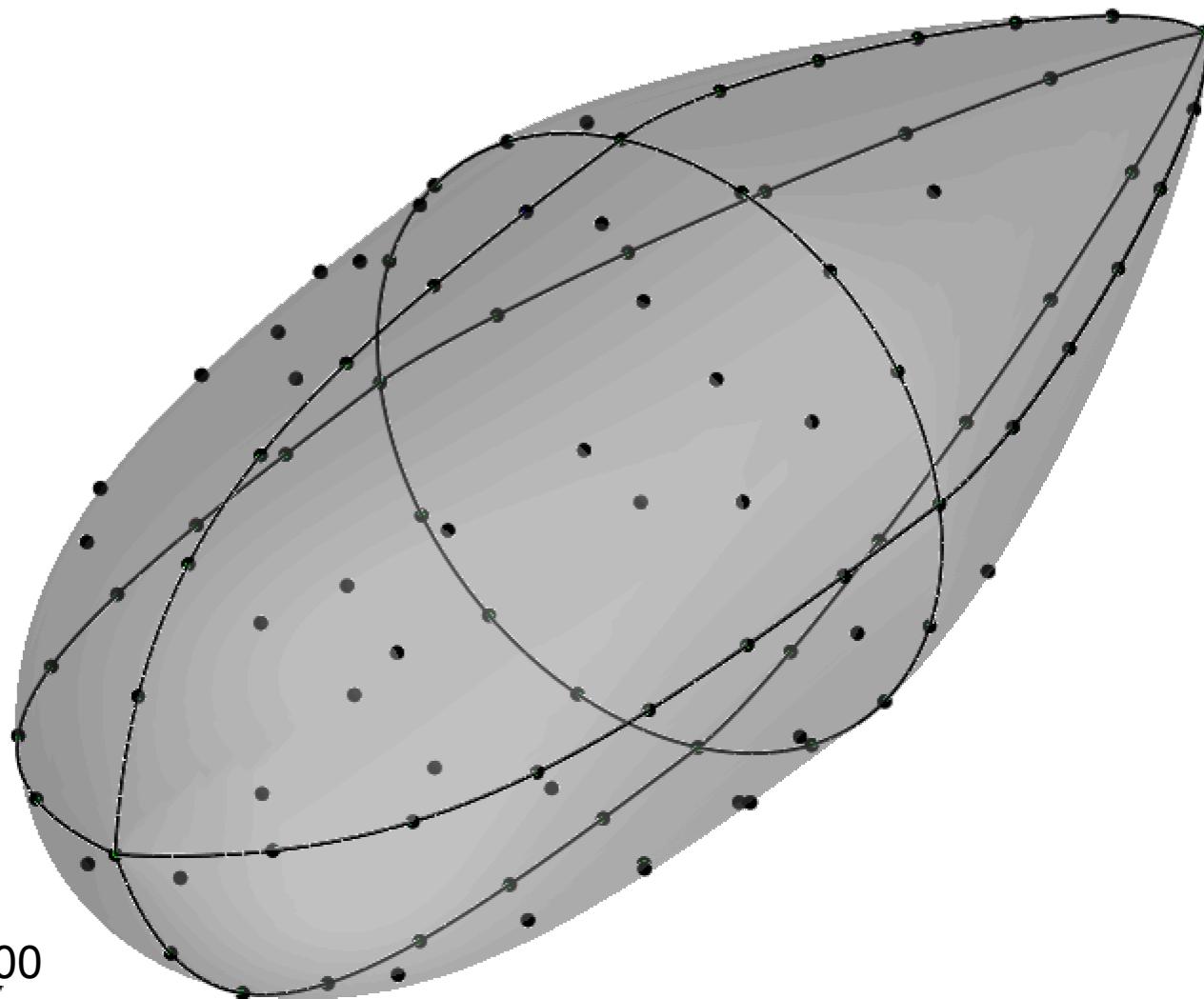




D=0.454112

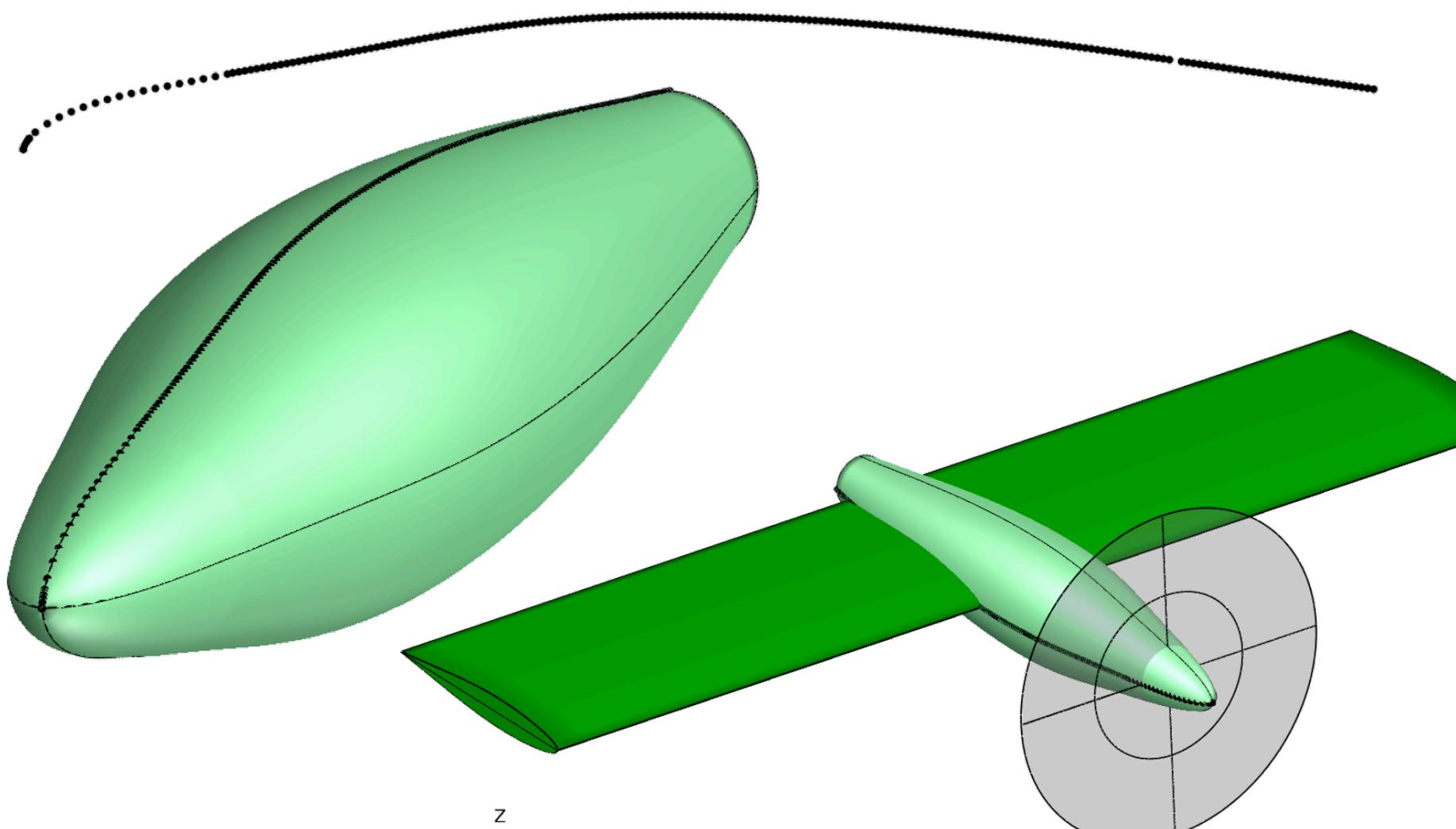


D=0.251781

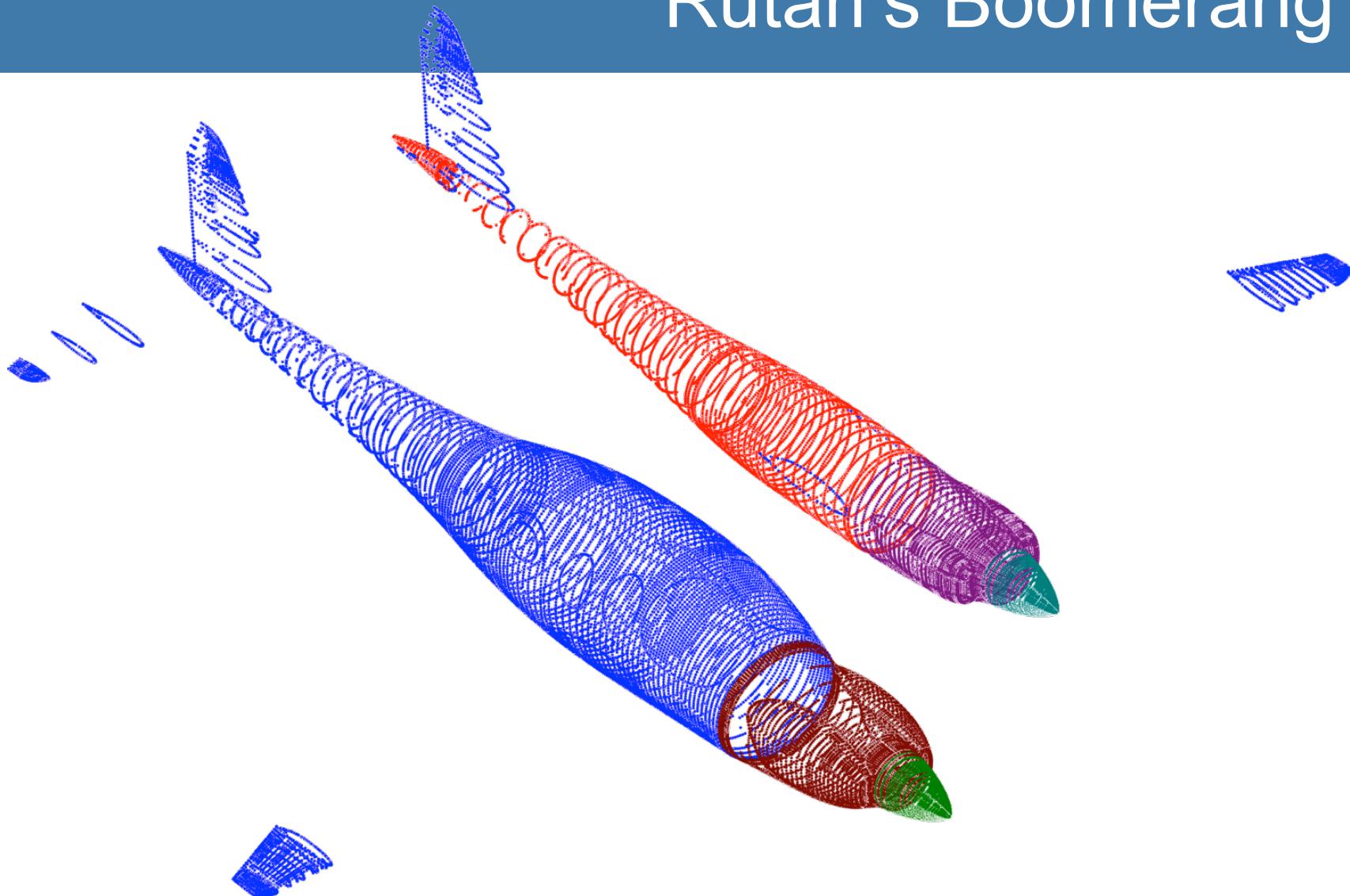


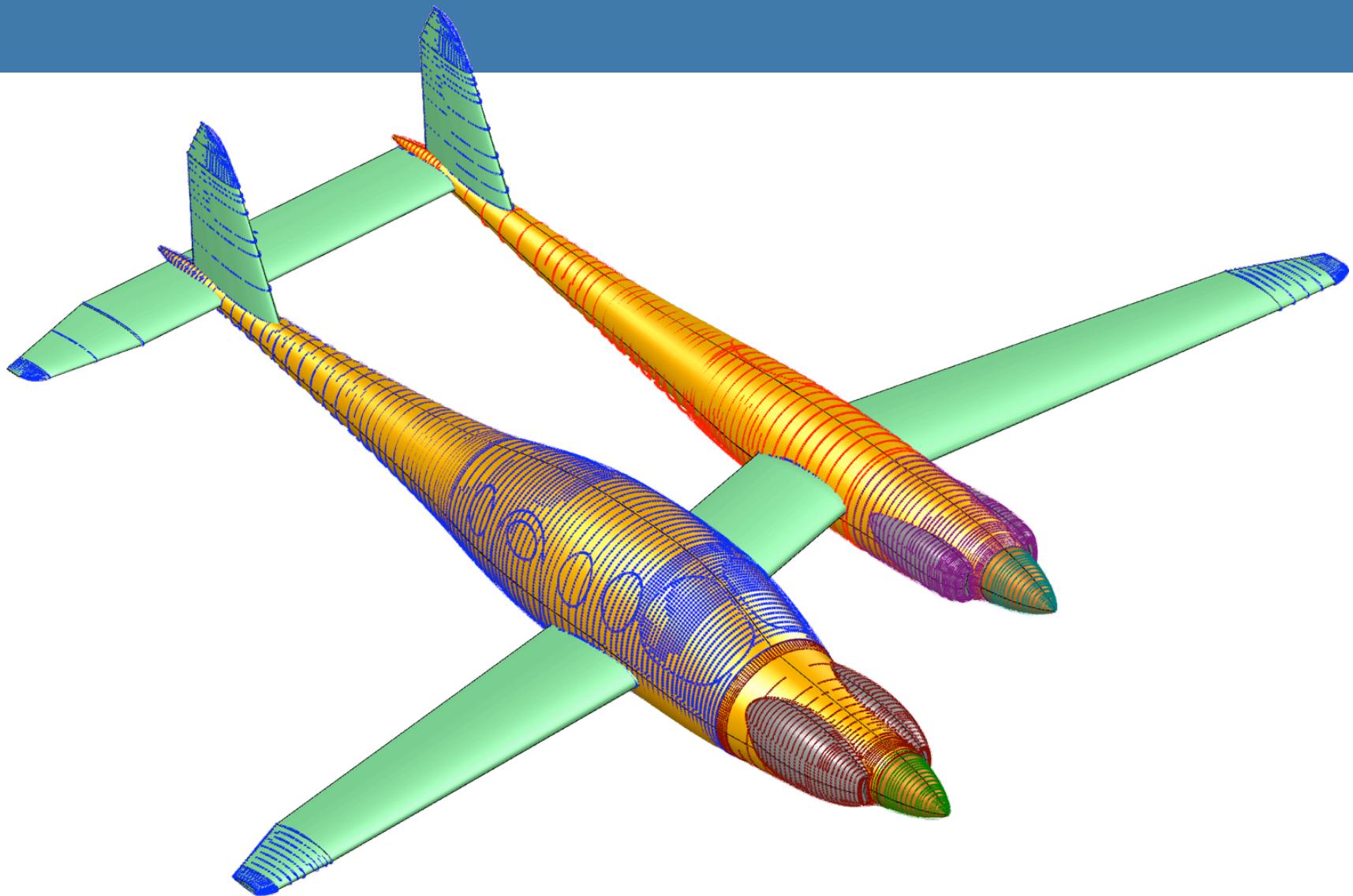
D=0.000000

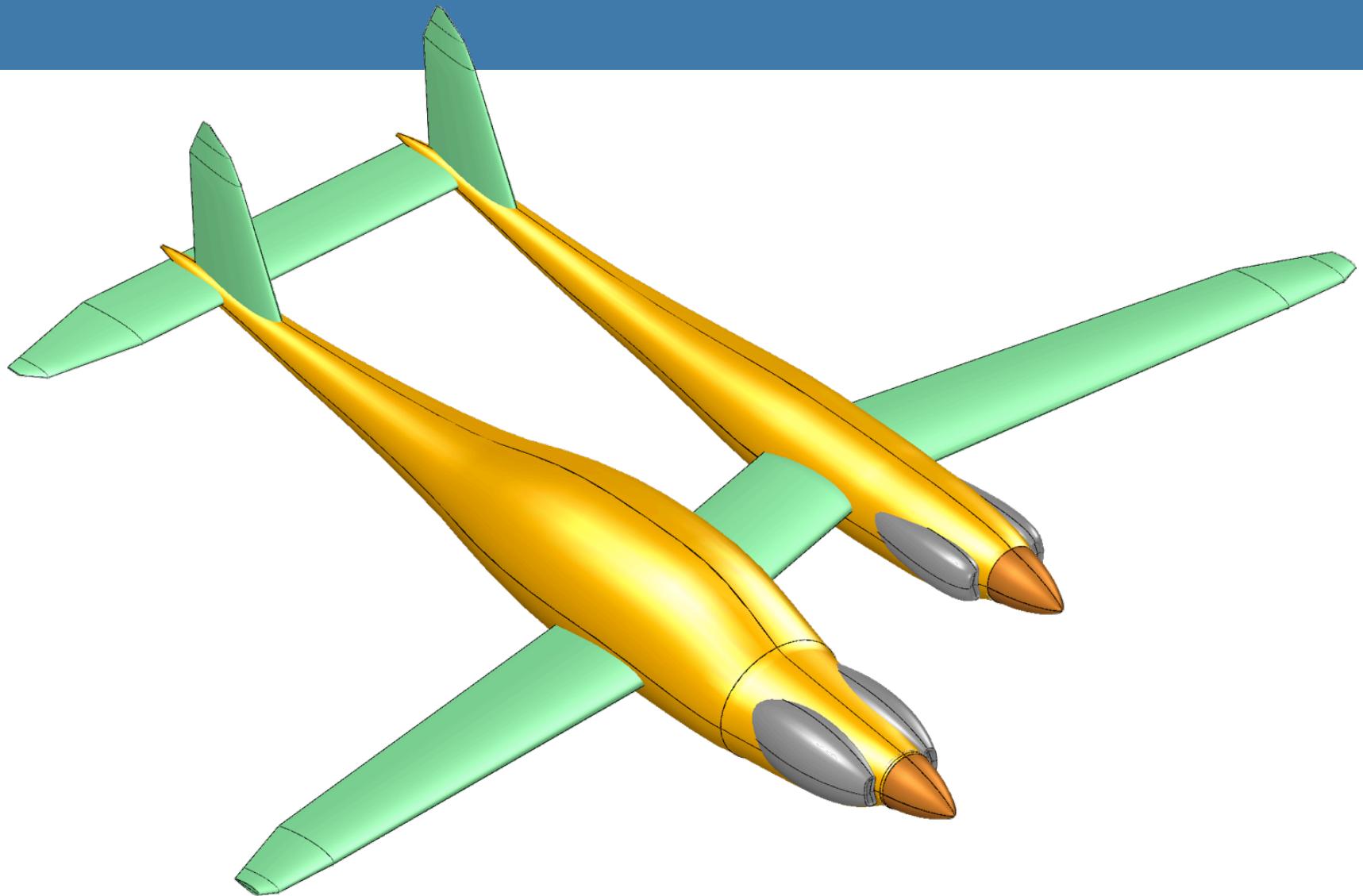
AGARD AR303 E6

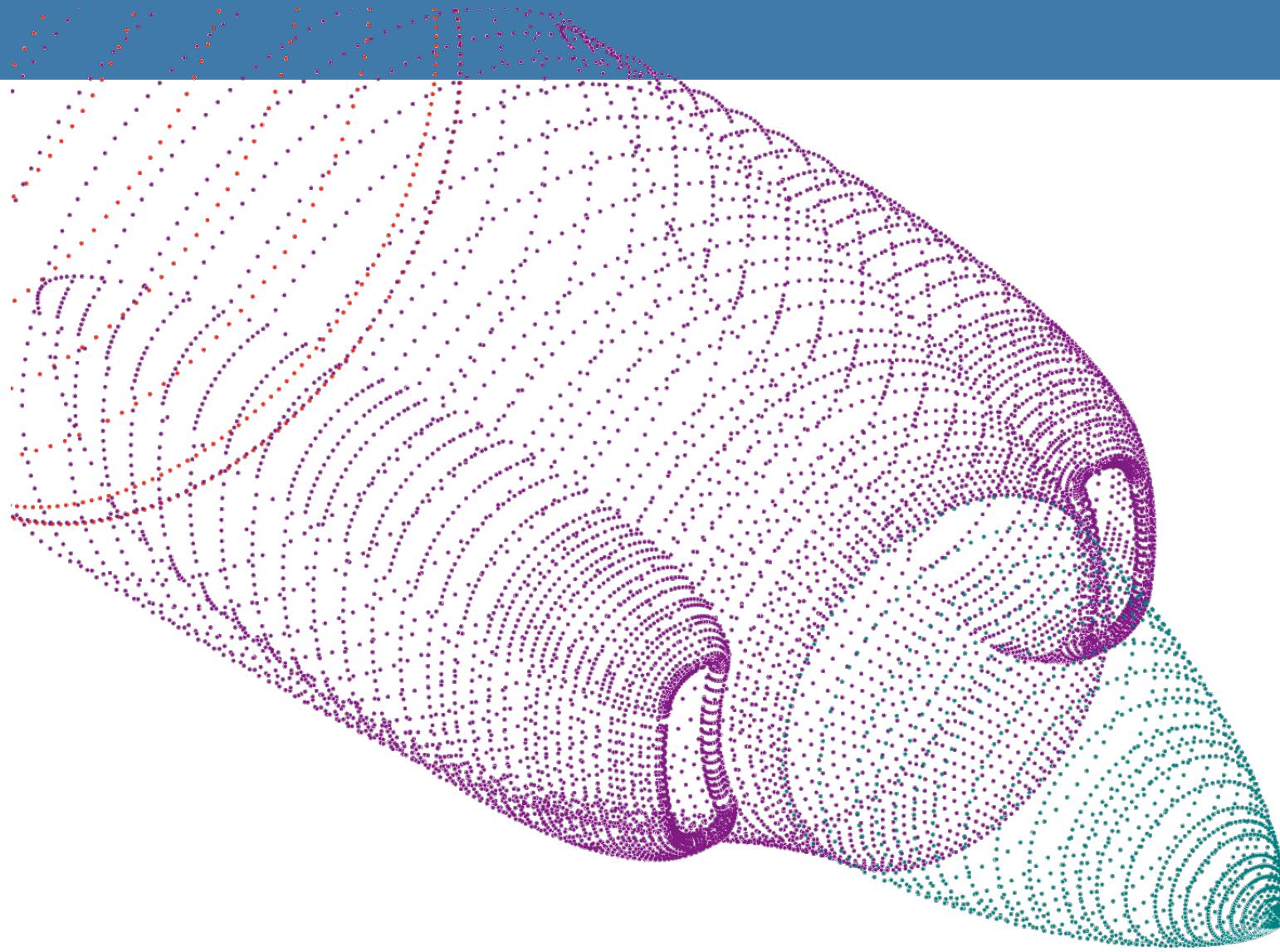


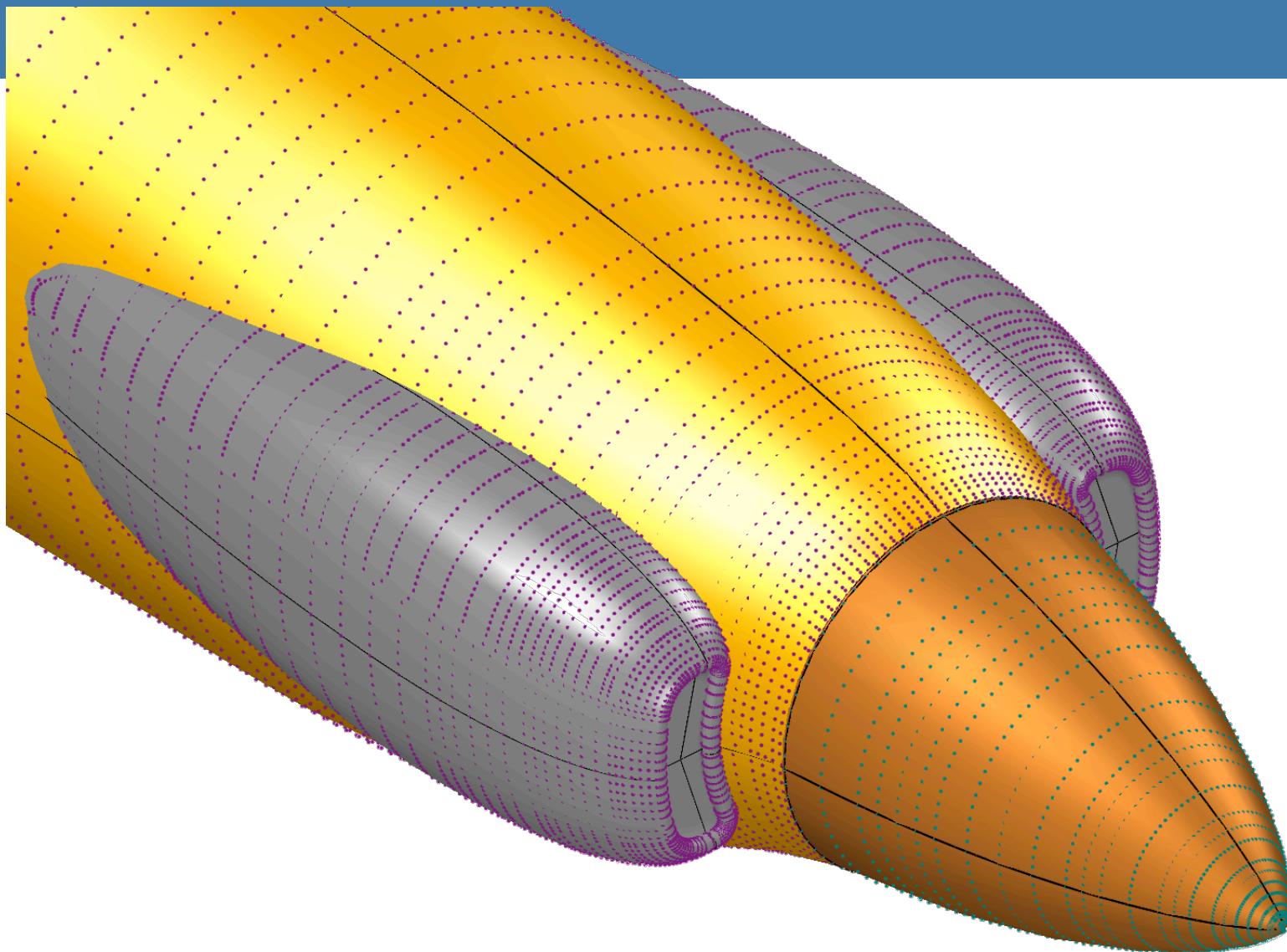
Rutan's Boomerang

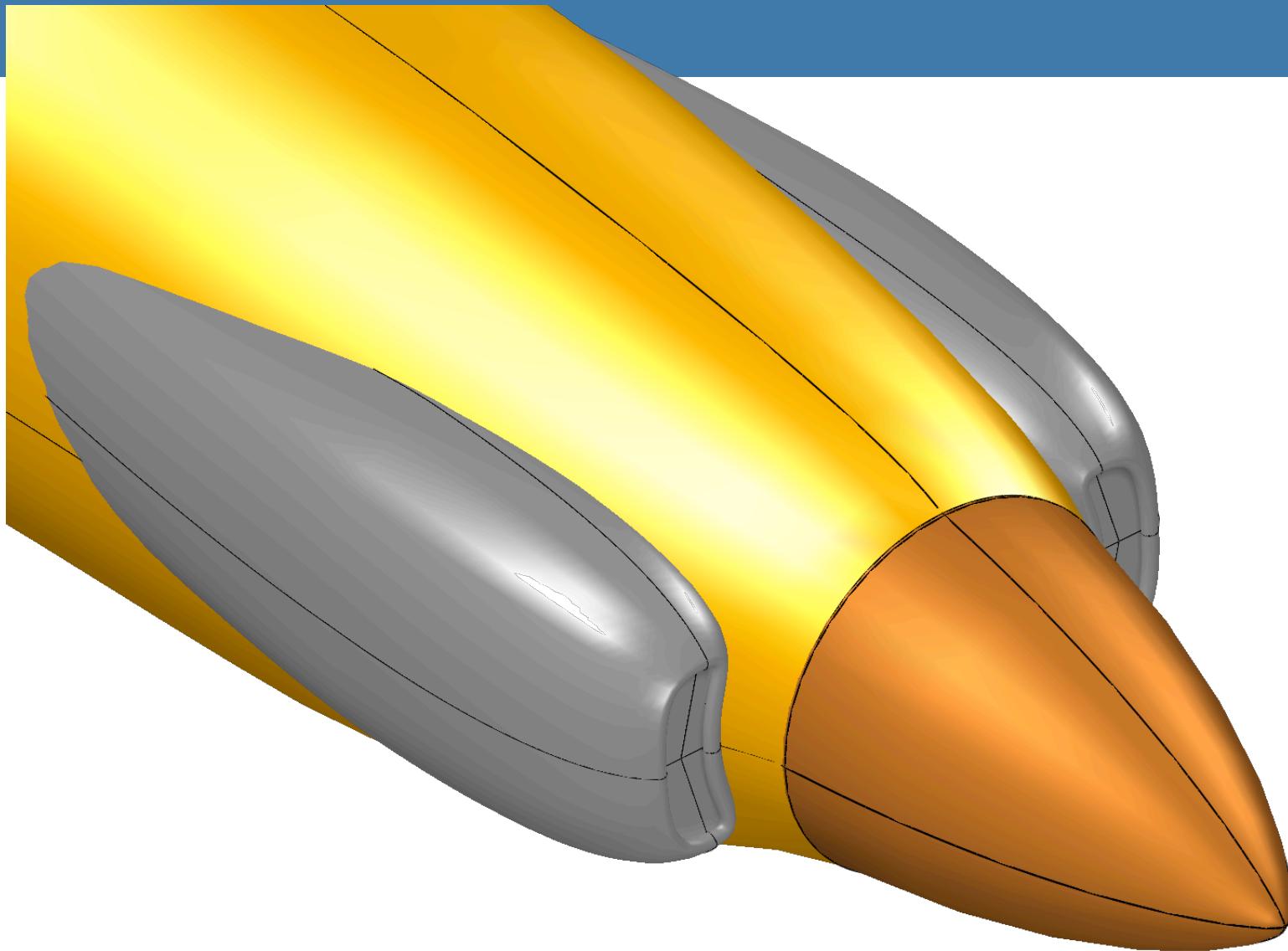




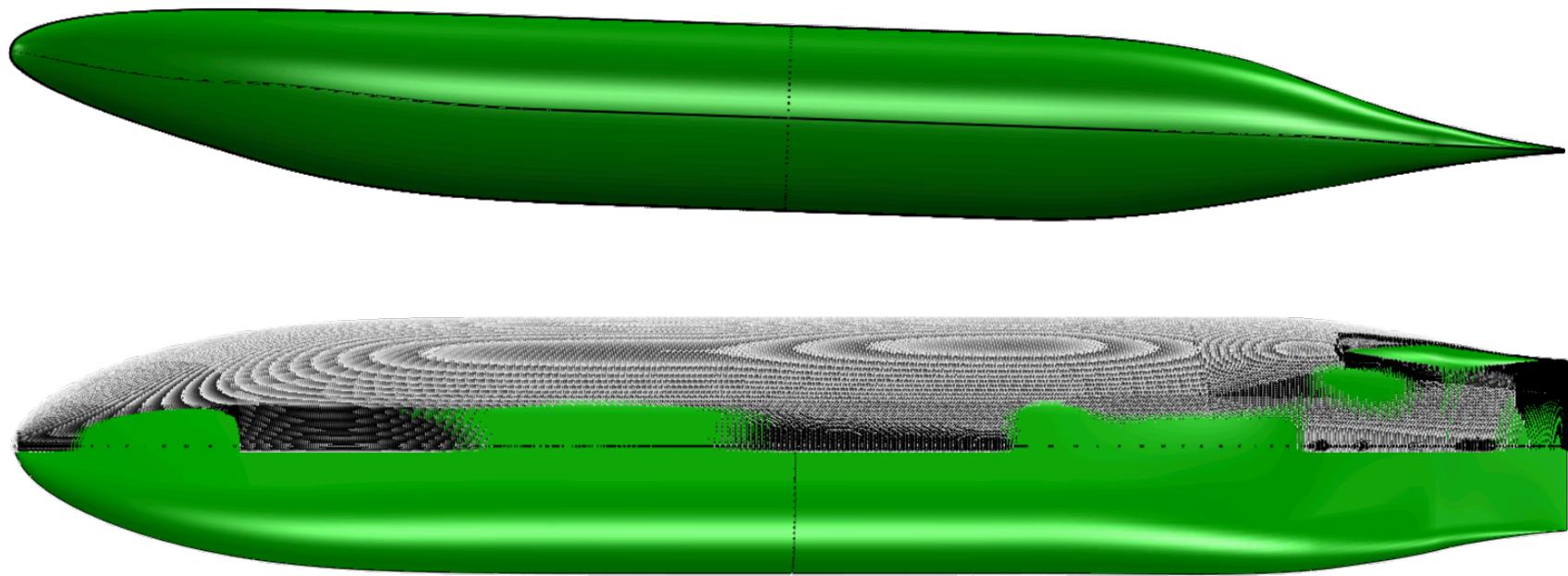




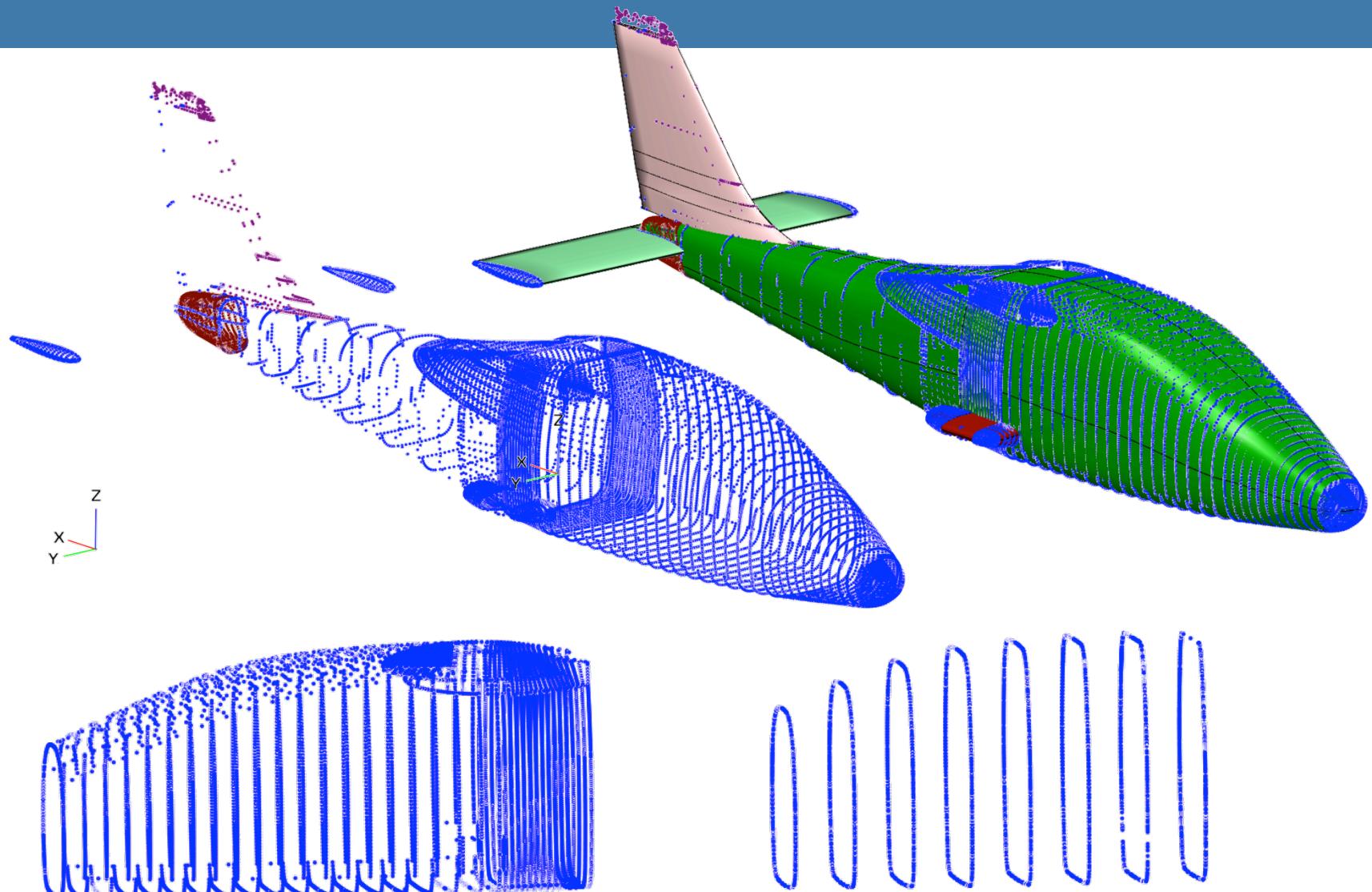




Drela's D8



Tecnam P2006



Questions?

Practice